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A Microprocessor-Based Automatic Frequency Controller

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I. INTRODUCTION

This paper describes a microprocessor-based (MAC-8/MAC-Tutor) automatic frequency controller (AFC) that has applications to satellite communications systems.[1] Since satellite orientation to the sun varies over a 24-hour period, the frequency of a source on a satellite is susceptible to diurnal thermal effects. These effects result in a characteristic variation in frequency which is both periodic and repeatable. Loss of signal on satellite links occurs primarily because of severe attenuation resulting from heavy rains along the satellite-to-earth path. When a loss of signal occurs the satellite source can drift outside of the receiver pull-in range. When this happens, the overall outage time is extended by the time required to search for and relocate the satellite frequency. If the AFC has some knowledge of the frequency variation, the time to reacquire the lost signal can be minimized and the overall outage time reduced.

The AFC described here reduces the uncertainty in the knowledge of the frequency of a source after a loss of signal. This uncertainty reduction is accomplished by using a microprocessor to estimate a current frequency from the last-known frequency and the rate of frequency change over a fixed time period from a previous day. Reducing the frequency uncertainty minimizes the time to reacquire the source after the lost signal reappears. The algorithms also search in frequency, track a varying frequency, and verify the acquisition of a valid signal.

II. MICROPROCESSOR AFC HARDWARE

Figure 1 is a block diagram of the microprocessor-based automatic frequency controller (AFC). The majority of its input and output operations occur over I/O ports that are already present on the microcomputer. The only exception to this is the operation of the real-time clock display. The clock display is driven by an additional I/O port that is accessed through a separate address decoder. The frequency display and synthesizer are driven through buffered I/O ports. Additional ports drive status indicators which display the current function in progress and read the mode-select switches. These switches allow the selection of several functions that can be executed while the AFC is in the manual model. The functions include the following: SLEW allows manual control of the local oscillator frequency; TRACK tracks a varying frequency while in manual; SET sets the overall full-frequency

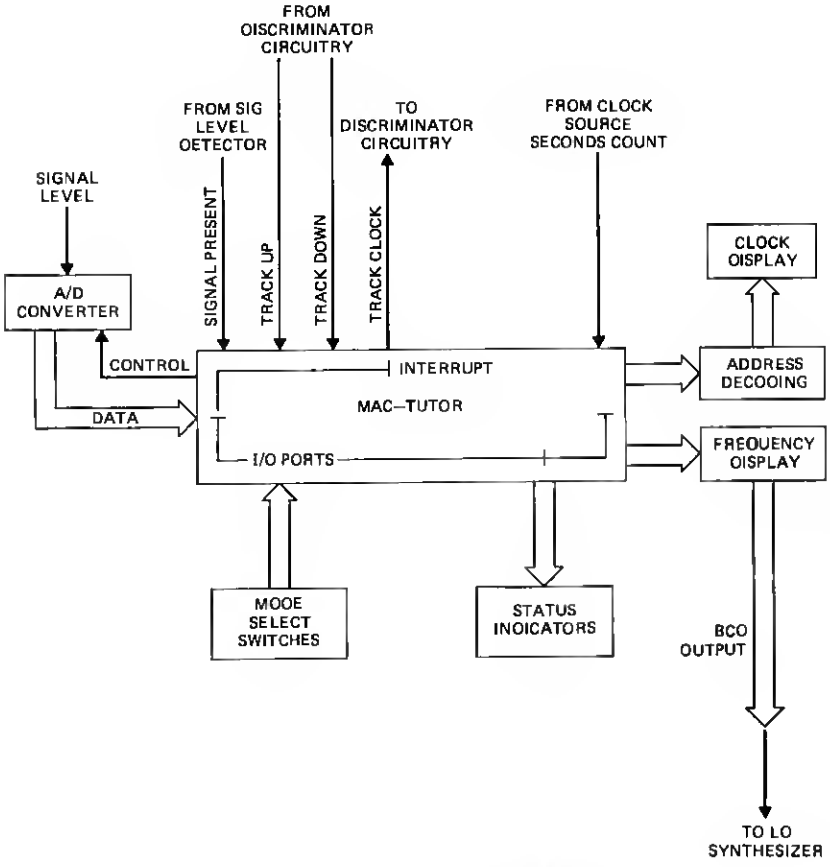

Fig. 1—MAC-Tutor AFC block diagram.

search limits, the search rate, and the real-time clock; and MAN/AUTO selects the mode of operation. MAN/AUTO functions are manually selected and are executed using an external keypad.

III. MICROPROCESSOR-BASED AFC SOFTWARE

The software used to implement the overall control algorithm consists of four control modules which execute calls to each other and to a library of subroutines or "functions." In addition to a real-time clock and interrupt handler, these modules include main-, automatic-, and manual-mode drivers which have been written in MAC-8 assembly language. Figure 2 illustrates the control structure. When an interrupt occurs, the first module updates a real-time clock and, based upon the status of the controller, processes the interrupt. A standard interrupt return simply returns control to the sub- or control program that was being executed at the time of the interrupt. Otherwise, program flow is channeled to the main module, from which control is passed either to the automatic- or manual-mode drivers. These modules access both

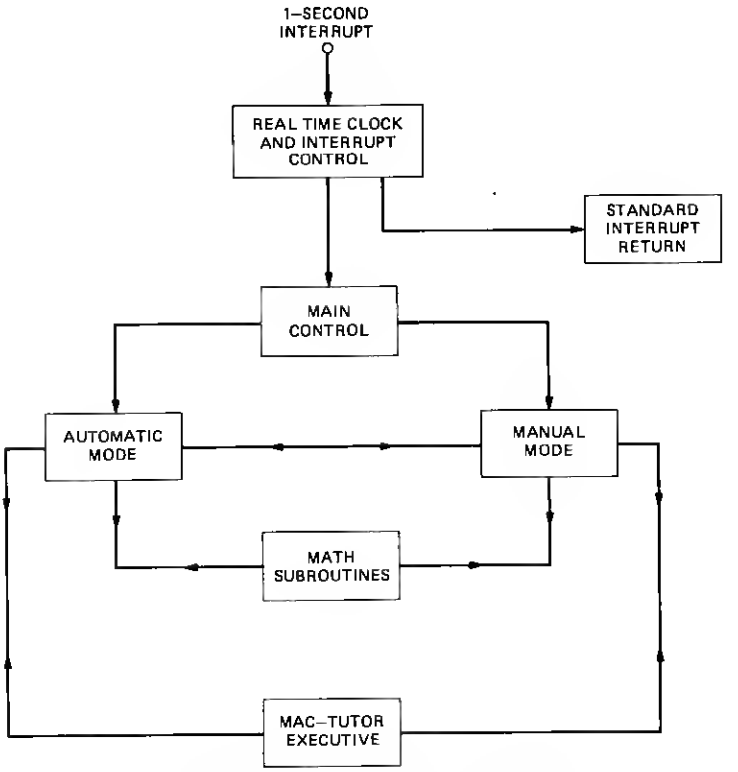

Fig. 2—Overall control algorithm flow diagram.

each other and subroutines which exist in the Math-Subroutine or MAC-Tutor Executive libraries.

IV. CONCLUSIONS

The AFC has been shown to track, acquire, and verify a source whose characteristics are similar to those of the 19-GHz COMSTAR satellite beacon.[1] Through the use of a microprocessor (MAC-8/MAC-Tutor) the AFC reduces the uncertainty in the knowledge of tbe frequency of a source after a loss of signal and provides automatic acquisition capabilities in the form of frequency extrapolation and signal verification. The AFC hardware has been designed to be general purpose. Its control algorithms are software based and can be easily modified for other applications. The system is flexible and can be used in other satellite measurement programs, satellite communication systems, or in any application in which the frequency characteristics of the source are periodic and repeatable.

REFERENCES

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